"Sensors with Wings" - Small UAVs for Earth Science

Geoff Bland[*]
NASA Goddard Space Flight Center, Wallops Island, VA, 23337

Patrick Coronado[†]
NASA Goddard Space Flight Center, Greenbelt, MD, 20771

Ted Miles[‡]
NASA Goddard Space Flight Center, Wallops Island, VA, 23337

Pat Bretthauer[§]
Star Aircraft Works, LLC, Silver Spring, MD, 20910

Allen Lunsford[**]
Global Science and Technology, Inc., Greenbelt MD, 20771

John Bognar[††]
Anasphere, Inc., Bozeman, MT, 59715

Small UAVs are showing promise for high resolution, quick response measurements for Earth science research. Several experiments have been conducted within the NASA Goddard Space Flight Center, to explore the potential utility of miniaturized sensors combined with small air vehicles for a variety of measurements and missions. Results indicate that there is a productive future for this class of aerial platform, and work is underway to create "Sensors with Wings" – integrated instrument/platform systems specifically tailored for *in-situ* and remote sensing observations.

I. Introduction

UNINHABITED Aerial Vehicles (UAVs) with a gross weight of less than 55 pounds are often referred to as "Mini UAVs". Our experiments have generally focused on this type, although there are some exceptions. For the purpose of these discussions, "small" UAVs may be defined as those that can carry scientific instrument payloads of up to 30 lbs. This definition includes a number of air vehicles that are commonly used for military operations, yet by comparison to the wide variety of UAV types, it is clear that our interests have focused on vehicles that can be dimensionally characterized as "small". Our tests have included research prototypes, modified hobby-type radio controlled (RC) models, and a commercially produced UAV, the BAI Aerosystems *Tern*.

Image 1. Prototype Research UAV

Image 2. Modified RC Model

Image 3. Production UAV

[*] Observational Science Branch/972, Laboratory for Hydrospheric Processes, Senior Member AIAA
[†] Senior Engineer, Applied Information Sciences Branch/935
[‡] Technician, Electrical Engineering Branch/569
[§] President, Star Aircraft Works, LLC
[**] Senior Systems Engineer, Global Science and Technology, Inc
[††] President, Anasphere, Inc.

Small UAVs offer significant potential for enhancing observations relevant to the study and understanding of our planet. Advantages include high spatial resolution by flying at slower speeds and lower altitudes than manned aircraft or many larger UAVs. For remote sensing and *in-situ* measurements, flight speeds as low as 15 mph have been demonstrated. Quick response is another highly desirable feature – a system can be integrated, stored, and transported easily. Specific atmospheric phenomena, agricultural condition, or special events such as satellite over-passes are key time-specific targets of interests that may be captured using the short lead-time of a pre-integrated flight system. Additionally, launch and recovery from small areas are benefits. We have explored hand-launched systems extensively, as these offer the potential for operations from unimproved areas.

We have demonstrated that this class of vehicle is certainly suitable for a wide range of observations; however, the challenges associated with these instrumented platforms are significant. Creating miniaturized sensor systems that are suitable for such tasks is difficult and often not fully appreciated. Wind sensitivity is also a limiting factor that must be balanced with desired mission profiles. Certainly operations beyond line-of-sight offer significant technological and operational hurdles. Additionally, flight operations are still evolving, and damage and attrition remains high. Activities that may help familiarize and train scientists and flight operators are being explored to encourage and facilitate wide-spread use of these systems.

II. Conclusion

It is clear that small UAVs will become a valuable tool for a variety of Earth science observations and applications. Fine-scale measurement capabilities combined with reasonable economics will provide the ability to obtain information that can be used to refine atmospheric models as well as analyze details beyond the resolution of satellite remote sensing systems. Portability, simplicity, and suitability for remote operations will enable new measurement missions to be conducted. Small UAVs will certainly become a popular tool for local scale observations in the near future, and will soon gain the systems capabilities required for routine long range missions.

Miniaturized sensors are particularly important, and significant instrument research is needed to parallel vehicle systems evolution. Small spectrometer systems are moving forward, and microwave instrument work has been initiated at NASA GSFC. Atmospheric sensors are also beginning to get underway in earnest. Remote sensing systems and atmospheric profiling capabilities are our primary focus during the short term. Atmospheric transects and flux measurements, as well as cloud studies are major objectives for the next several years. We will also begin to address training requirements of users and operators, and participate in the development of guidelines for airspace use. Collaboration with industry, academia and NASA's Science and Aeronautics Research Directorates is critical.

As the result of work conducted over the past decade, it is clear that UAVs can be productive for scientific observations by tailoring platforms to specific instrument systems and missions, creating "*Sensors with Wings*".

Image 23. *Xaposoarus* Landing on Wallops Island